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FOREST ENVIRONMENTAL PROTECTION

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DWARF MISTLETOE CONTROL - WHY AND WHAT?

An Appraisal of the Northern Region Control Program

by

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ABSTRACT

Dwarf mistletoes exert an impact on forest productivity, but this impact can be reduced through management practices. Even infested stands can yield considerable volumes if proper control methods are used. Projections of future yield increases due to control efforts are made. Cost of treatment in fiscal year 1973 was $51 per acre in Douglas-fir and western larch and $19 per acre in lodgepole pine. The benefit:cost ratio of control is 3.25:1 in Douglas-fir and western larch and 2.42:1 in lodgepole pine. These benefit:cost ratios are based on primary resource values alone, and do not include value added to the economy in wages and social benefits. Control was accomplished on nearly 9,000 acres in fiscal year 1973; Insect and Disease Control funds accounted for about one-half the expenditures. The control program should be continued. Steps for the land manager to take for program continuation are recommended.

INTRODUCTION

Dwarf mistletoes (*Arceuthobium* spp.) rank high as important forest disease organisms in the Northern Region. Growth loss due to dwarf mistletoe is second only to that caused by heartwood decay fungi (Gill, 1935). Combined losses to mortality and growth reduction due to these parasites in the western United States total about 3.2 billion board feet annually (USDA Forest Service, 1969).

Dwarf mistletoes are obligate, parasitic seed plants, dependent upon their seed for reproduction and spread. Nature of seed dispersal is unfavorable for long-distance spread (Hawksworth, 1961). Birds, rodents, and wind have no appreciable effect on seed dispersal (Hawksworth, 1961). Dwarf mistletoe is destroyed by removal of infected host parts; therefore, it can be reduced to a tolerable level by removal of infected trees as an integral part of managing the stand.

WHY ARE WE DOING IT?

Growth impact.--Studies on lodgepole pine (*Pinus contorta* Dougl.) show a volume reduction of about 33 percent in mature, infested stands as compared with mature, healthy stands (Hawksworth, 1958a). Other studies on

lodgepole pine (Hawksworth and Hinds, 1964) and Douglas-fir *(Pseudotsuga menziesii* (Mirb.) Franco) and western larch (*Larix occidentalis* Nutt.) (Haglund and Dooling, 1972; On and Dooling, 1969; Pierce, 1960; Weir, 1916, 1918) have shown marked reductions in height and diameter growth. In addition to losses of diameter increment and height growth, dwarf mistletoes cause some mortality (Hawksworth and Lusher, 1956; Korstian and Long, 1922). Infected trees show a loss of vigor, increasing their susceptibility to attacks by other diseases and insects, and shortening the life expectancy of the stand (Hawksworth, 1961; Korstian and Long, 1922). A decrease in quantity, quality, and germination percentage of seeds produced by infected trees has been reported (Korstian and Long, 1922).

Effect of thinning on spread and intensification.--Thinning timber stands normally increases the growth of trees by reducing competition for light, moisture, and nutrients. Dwarf mistletoe plants on the residual trees also respond with an accelerated growth rate. This increase in growth rate of the dwarf mistletoe is due to an increase in light and an increase in available food produced by the tree. With this increased growth rate, two things happen: an increase in seed production by the dwarf mistletoe plant, resulting in a faster rate of infection spread to nearby trees; and an increased impact on the growth of the tree because of the demand for nutrients to maintain the parasite's increased growth rate.

This begins to have the appearance of a vicious circle, but the situation is not as bad as it seems to be. Factors that determine the seriousness of the problem are: how much infection is present after thinning, what infection classes are present after thinning, what the distribution of infection is, what the response of the trees was to the thinning, and what followup is to be done in the stand.

In the six-class infection rating system (Hawksworth, 1961), trees go from Class 0, no infection to Class 6, heavy infection. Based on our observations and preliminary results of impact studies, Class 1 and Class 2 infections do not measurably affect the growth rate of a tree. It appears that stocking density is much more important than infection up to the Class 3 infection level. 1/ 2/

If a good job of thinning/dwarf mistletoe control is accomplished there should be no residual trees with a Class 3 or higher infection. By assuming a good response to the thinning, we can plan on making another cut in 20 to 30 years. It takes about 14 years for a tree to move from one infection class to the next higher one (Hawksworth and Hinds, 1964). In 30 years, a Class 1 tree will be a Class 3 tree; a Class 2 tree will be a Class 4 tree; and the remainder of the stand will be no worse than Class 2, with many Class 0 and 1 trees. The growth rate of the Class 2 and lower trees should more than offset the slowdown in growth of the Class 3 and

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1/ Personal communication from Ed F. Wicker, Intermountain Forest and Range Expt. Sta., Forestry Sciences Lab., Moscow, Idaho.

2/ Unpublished data from the author.

4 trees. If the next cut is made in 20 years, there should not be any trees higher than Class 3, and only these Class 3 trees will be declining in growth rate.

Effect of regeneration cutting on spread and intensification.--Pathologically, the highest level of control is obtained with the clearcut. This means a clean cut, in which all trees over 1 foot in height, both merchantable and unmerchantable, are removed. Anything less is only "a very crude application of the selection method" (Smith, 1962).

Seed tree and shelterwood cuts are satisfactory control methods if the land manager provides for prompt removal of the overstory as soon as it has served its purpose, which is to provide a seed source and/or site protection for establishment of natural regeneration. Once regeneration is established, it is not pathologically sound to leave the overstory, since many of the trees are infected.

Each infected overstory tree left after the regeneration cut provides enough dwarf mistletoe seed to infest about 1 acre of reproduction (Parmeter and Scharpf, 1972). By leaving only one infected overstory tree per acre, we have not improved the dwarf mistletoe situation.

These are in reality prevention methods rather than control methods. By removing the dwarf mistletoe seed source, most of the stand will be free of infestation for many years. Some infection will occur around the perimeter, but the rate of spread through an even-storied stand is only 2 feet per year (Hawksworth, 1958b; Hawksworth and Gill, 1960). The infected trees around the perimeter can be removed in either precommercial or commercial thinnings as the stand matures.

WHAT ARE WE BUYING? 3/

Benefit/cost analysis in Douglas-fir and western larch.--A study in western larch showed that yields in heavily infested stands can be reduced to less than 20 percent of potential and lightly infested stands to about 70 percent of potential (On and Dooling, 1969). A similar study in Douglas-fir showed that infested stands were growing at less than 40 percent of potential (Haglund and Dooling, 1972). Based on these two studies, infested mixed stands of these two species are growing at an average of about 50 percent of their potential. By combining dwarf mistletoe control practices with thinning, infested stands can yield 90 percent of their potential (FSH 2409.21g Region 1, Management of western larch, Northern Region). Assuming a 40-year-old stand is treated (control plus thinning), the following per acre loss can be recovered in successive 20-year cuttings:

3/ Robert Lovegrove, economist, USFS Region 1, assisted with the economic analysis.

Cutting age	Healthy stand potential (MBF)	Infested stand potential (MBF)	Managed infested stand potential (MBF) a/	Growth loss w/o treatment (MBF)	Growth recovery w/treatment (MBF) b/	Value/MBF ($) c/	Total recovery value ($)
60	16	8	14.4	6.4	5.1	59	301
80	28	14	25.2	11.2	9.0	59	531
100	36	18	32.4	14.4	11.5	59	678

a/ 90 percent of healthy stand potential.
b/ Assuming 80 percent recovery of growth loss.
c/ Average stumpage value at end of fourth quarter, FY 1973.

By applying a 6 percent discount rate to these values, we can determine the present net worth (pnw) for benefits derived from dwarf mistletoe control combined with thinning as follows:

Time (n)	Dollar value	Discount factor a/	pnw
20	301	0.3118	94
40	531	.0972	52
60	678	.0303	20
Total	1,510		166

a/ Present value of $1 for n years.

Cost of treatment in FY 1973 was $51 per acre. By dividing the pnw of the total benefits derived by the treatment cost, the benefit:cost ratio is 3.25:1. Insect and Disease control funds account for 71 percent of the total cost of treatment (control plus thinning).

The recovery of the volume loss will generate additional employment in the forest products industry. Each million board feet of timber cut creates

7 man-years of employment paying an average of $10,000 per man-year.[4/] This will generate 0.05, 0.09, and 0.11 man-years of employment per acre in 20, 40, and 60 years respectively. The additional wages can be summarized as follows:

Cutting age	Man-years per acre	Employment value/man-year	Total wages
60	0.05	10,000	500
80	.09	10,000	900
100	.11	10,000	1,100
Total	.25		2,500

These calculations assume that the value of stumpage will remain at present levels for 20, 40, and 60 years. This is probably a false assumption; stumpage prices will continue to rise and the benefits of investing $51 per acre now will be higher than these calculations show.

Benefit:cost analysis in lodgepole pine.--A yield simulation was recently completed in a 30-year-old stand of infested lodgepole pine on the Gallatin National Forest. We used a computer program developed at the Rocky Mountain Forest and Range Experiment Station (Myers, et al., 1971; Hawksworth and Myers, 1973).

The site index was 60, average d.b.h. was 4.6 inches, and the stand contained 2,520 trees per acre. Dwarf mistletoe infection started at age 11. We ran the simulation program two ways:

1. Thin at age 30 (now), 50, 70, and 90 to a stocking level of 100; and clearcut at age 110.

2. Thin at age 60 to a stocking level of 100; and clearcut at age 120.

The yield table for thinning now and at 20-year intervals shows a recovery of 424, 429, and 598 merchantable cubic feet/acre at age 50, 70, and 90, respectively. (This converts to 2,543 board feet of sawtimber at age 90.) Final volume at age 110 is 3,349 cubic feet (15,332 board feet). The yield table is shown in Table 1.

If we wait until age 60 to make the first thinning, no volume is produced. The final yield at age 120 is only 1,759 cubic feet; no sawtimber is produced. The yield table is shown in Table 2.

The average dwarf mistletoe rating at rotation age, using the six-class system (Hawksworth, 1961), for the stand is 1.1 by thinning at age 30, and 6.0 for no thinning until age 60. This indicates that thinning at an early age keeps the infection rating at a level low enough to have a minimal effect on stand growth.

4/ Personal communication from A. L. Hearst, Jr., Forest Products Utilization Specialist, Northern Region, USFS, Missoula, Montana.

TABLE 1.--YIELDS PER ACRE OF EVEN-AGED STANDS OF LODGEPOLE PINE
SITE INDEX 60
THINNING INTENSITY- INITIAL- 100 SUBSEQUENT- 100

	ENTIRE STAND BEFORE AND AFTER THINNING							PERIODIC INTERMEDIATE CUTS				
STAND AGE (YEARS)	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	AVERAGE HEIGHT FT.	TOTAL VOLUME CU.FT.	MERCHANTABLE VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	TREES NO.	BASAL AREA SQ.FT.	TOTAL VOLUME CU.FT.	MERCHANTABLE VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.
30	2520	291	4.6	23	2940	0	0					
30	1506	131	4.0	22	1320	0	0	1014	160	1620	0	0
40	1344	148	4.5	28	2010	0	0					
50	1175	160	5.0	32	2470	1003	0					
50	399	63	5.4	33	1060	579	0	776	97	1410	424	0
60	396	86	6.3	40	1700	1313	0					
70	395	109	7.1	45	2450	2111	0					
70	291	85	7.3	45	1930	1682	0	104	24	520	429	0
80	290	104	8.1	50	2590	2315	9300					
90	290	122	8.8	53	3290	2937	12300					
90	219	97	9.0	54	2620	2339	9757	71	25	670	598	2543
100	217	114	9.8	57	3260	2978	12576					
110	215	129	10.5	60	3880	3349	15332					

DWARF MISTLETOE INFECTION STARTED AT AGE 11 AND RATING WAS 1.1 AT AGE 110

MERCH. CU. FT. - TREES 6.0 INCHES D.B.H. AND LARGER TO 4-INCH TOP.

BD. FT. - TREES 6.5 INCHES D.B.H. AND LARGER TO 6-INCH TOP.

TABLE 2.-- YIELDS PER ACRE OF EVEN-AGED STANDS OF LODGEPOLE PINE
SITE INDEX 60
THINNING INTENSITY- INITIAL- 100 SUBSEQUENT- 90

	ENTIRE STAND BEFORE AND AFTER THINNING							PERIODIC INTERMEDIATE CUTS				
STAND AGE (YEARS)	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	AVERAGE HEIGHT FT.	TOTAL VOLUME CU.FT.	MERCHANTABLE VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	TREES NO.	BASAL AREA SQ.FT.	TOTAL VOLUME CU.FT.	MERCHANTABLE VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.
60	2520	291	4.6	29	3820	0	0					
60	2520	291	4.6	29	3820	0	0	0	0	0	0	0
70	1667	201	4.7	33	3160	0	0					
80	1258	165	4.9	36	2880	0	0					
90	920	136	5.2	38	2530	1221	0					
100	771	127	5.5	39	2460	1443	0					
110	646	119	5.8	40	2370	1585	0					
120	541	113	6.2	41	2330	1759	0					

DWARF MISTLETOE INFECTION STARTED AT AGE 11 AND RATING WAS 6.0 AT AGE 120

NOTE THAT NOT ALL SCHEDULED THINNINGS WERE POSSIBLE.

MERCH. CU. FT. - TREES 6.0 INCHES D.B.H. AND LARGER TO 4-INCH TOP.

BD. FT. - TREES 6.5 INCHES D.B.H. AND LARGER TO 6-INCH TOP.

Using the volumes from the yield simulation, the following volumes and values can be recovered by thinning/dwarf mistletoe control at age 30 and subsequent 20-year intervals:

Cutting age	Volume recovery (Ft^3)	Conversion factor a/	Volume recovery (MBF)	Value per MBF b/	Total recovery value ($)
50	424	4.25	1.8	49	88
70	429	4.25	1.8	49	88
90	598	4.25	2.5	49	122
110	3,349	4.58	15.3	49	750
Totals	4,800		21.4		1,048

a/ Board feet per cubic foot.
b/ Average stumpage value at end of fourth quarter, FY 1973.

By applying a 6 percent discount rate to these values, we can determine the present net worth (pnw) for benefits derived from dwarf mistletoe control plus thinning as follows:

Time (n)	Dollar value	Discount factor a/	pnw ($)
20	88	0.3118	27
40	88	.0972	8
60	122	.0303	4
80	750	.0095	7
Totals	1,048		46

a/ Present value of $1.00 for n years.

Cost of treatment in FY 1973 was $19 per acre in lodgepole pine. By dividing the pnw of the total benefits derived by the treatment cost, the benefit:cost ratio is 2.42:1. Insect and Disease Control funds account for 37 percent of the total cost of treatment (control plus thinning or site rehabilitation).

Each million board feet of timber cut creates 7 man-years of employment paying an average of $10,000 per man-year. 4/ This will generate 0.018, 0.018, 0.025, and 0.153 man-years of employment in 20, 40, 60, and 80 years respectively. The additional wages can be summarized as follows:

Cutting age	Man-years per acre	Employment value/man-year	Total wages
50	0.018	10,000	180
70	.018	10,000	180
90	.025	10,000	250
110	.153	10,000	1,530
Total	.214		2,140

These calculations assume that the value of stumpage will remain at present levels for 60 and 80 years. This is probably a false assumption; stumpage prices will continue to rise and the benefits of investing $19 per acre now will be higher than these calculations show.

WHAT WE DID IN FISCAL YEAR 1973

Accomplishments.--The dwarf mistletoe control program for fiscal year 1973 was atypical; much of the money originally allotted to the National Forests for control was withdrawn. The following summary, however, shows what can be accomplished on a limited budget.

The program as proposed by the National Forests and the Flathead Indian Reservation was to treat slightly over 19,000 acres at a cost of about $578,000. Insect and Disease Control funds requested were slightly over $308,000. The proposed program is shown in Table 3.

The original allotment to the National Forests was $150,000. Part of the funds were withdrawn before they were obligated by the Forests; the final allotment was $62,555. The $50,000 requested by the Flathead Indian Reservation was allotted to the BIA at the Washington Office level and was not withdrawn. Control was accomplished on nearly 9,000 acres at a total cost of about $222,000. Insect and Disease Control expenditures accounted for about one-half the total cost. The program accomplishments are shown in Table 4.

SHOULD WE CONTINUE IT?

The answer to this question is yes, because there are benefit:cost ratios of 3.25:1 in Douglas-fir and western larch, and 2.42:1 in lodgepole pine (based on present stumpage values). These benefit:cost ratios are based on primary resource values alone and do not include value added to the economy in wages and social benefits.

The steps to take to continue the program are outlined in the following recommendations:

1. Determine management objectives for each unit.

2. If the primary objective is not timber production, ignore dwarf mistletoe infection, since its impact on other resources is negligible.

Table 3.--Proposed dwarf mistletoe control program for F.Y. 1973, Northern Region.

Forest	Acres	Cost		
		I&DC	Other	Total
Beaverhead	3,639	26,205	45,751	71,956
Colville	990	20,000	40,000	60,000
Deerlodge	5,960	74,921	4,050	78,971
Flathead	340	5,855	12,093	17,948
Gallatin	2,467	39,744	58,265	98,009
Helena	969	23,404	0	23,404
Lewis & Clark	416	5,458	8,076	13,534
Lolo	2,879	55,773	91,575	147,348
Nezperce	463	7,023	9,494	16,517
Flathead Indian Reservation	1,000	50,000	0	50,000
Totals	19,123	308,383	269,304	577,687

Table 4.--Dwarf mistletoe control accomplishments for F.Y. 1973, Northern Region.

Forest	Acres	Cost		
		I&DC a/	Other	Total
Beaverhead	2,427	12,618	15,000	27,618
Colville	310	2,502	11,958	14,460
Deerlodge	1,590	14,471	39,540	54,011
Flathead	237	3,624	12,793	16,417
Gallatin	952	11,862	20,520	32,382
Helena	2,124	9,078	9,980	19,058
Lewis & Clark	223	1,400	0	1,400
Lolo	120	4,500	0	4,500
Nezperce	0	2,500 b/	0	2,500
Flathead Indian Reservation	1,000	50,000	0	50,000
Totals	8,983	112,555	109,791	222,346

a/ Final allotment to Forest.
b/ Obligated overhead assessments, no control accomplished.

3. If primary land management objective is timber production, determine

a. Presence or
b. Absence of infection.

4. If infection is present, determine

a. Distribution and
b. Intensity.

5. Decide for or against control.

6. If the decision is for control, determine

a. Best method to use, and
b. How to integrate the control method into the unit management plan.

7. Determine financing needs and source of funds.

8. If Insect and Disease Control funds are needed, submit Form 5200-10, Project Proposal, to the Regional Office by October 15 preceding the fiscal year for which the funds are needed.

9. For technical assistance in any phase of the control program, help is as near as the telephone: contact State and Private Forestry, Regional Office.

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